Nutrient and other environmental controls of harmful cyanobacterial blooms along the freshwater-marine continuum?

Paerl, H.W. University of North Carolina at Chapel Hill, Institute of Marine Sciences, Morehead City, NC 28557 (hpaerl@email.unc.edu)

Abstract

Nutrient and hydrologic conditions strongly influence harmful planktonic and benthic cyanobacterial bloom (CHAB) dynamics in aquatic ecosystems ranging from streams and lakes to coastal ecosystems. Urbanization, agricultural and industrial development have led to increased nitrogen (N) and phosphorus (P) discharge, which affect CHAB potentials of receiving waters. The amounts, proportions and chemical composition of N and P sources can influence composition, magnitude and duration of blooms. This, in turn, has ramifications for food web dynamics (toxic or inedible CHABs), nutrient and oxygen cycling and nutrient budgets. Some CHABs are capable of N_2 fixation, a process that can influence N availability and budgets. Certain invasive N_2 fixing taxa (e.g., *Cylindrospermopsis*, *Lyngbya*) also effectively compete for fixed N during spring, N-enriched runoff periods, while they use N_2 fixation to supplant their N needs during N-deplete summer months. Control of these taxa is strongly dependent on P supply. However, additional factors, such as molar N:P supply ratios, organic matter availability, light attenuation, freshwater discharge, flushing rates (residence time) and water column stability play interactive roles in determining CHAB composition (i.e. N_2 fixing vs. non-N_2 fixing taxa) and biomass. Bloom potentials of nutrient-impacted waters are sensitive to water residence (or flushing) time, temperatures (preference for >15 ^{o}C), vertical mixing and turbidity. These physical forcing features can control absolute growth rates of bloom taxa. Human activities may affect “bottom up” physical-chemical modulators either directly, by controlling hydrologic, nutrient, sediment and toxic discharges, or indirectly, by influencing climate change. Control and management of cyanobacterial and other phytoplankton blooms invariably includes nutrient input constraints, most often focused on N and/or P. While single nutrient input constraints may be effective in some water bodies, dual N and P input reductions are usually required for effective long-term control and management of blooms. In some systems where hydrologic manipulations (i.e., plentiful water supplies) are possible, reducing the water residence time by flushing and artificial mixing (along with nutrient input constraints) can be effective alternatives. Blooms that are not readily consumed and transferred up the food web will form a relatively large proportion of sedimented organic matter. This, in turn, will exacerbate sediment oxygen demand, and enhance the potential for oxygen depletion and release of nutrients back to the water column. This scenario is particularly problematic in long-residence time (i.e., months) systems, where blooms may exert a strong positive feedback on future events. Implications of these scenarios and the confounding issues of climatic (hydrologic) variability, including droughts, tropical storms, hurricanes and floods, will be discussed in the context of developing effective CHAB control strategies along the freshwater-marine continuum.